

**Investigation Report**  
**H2S Exposure near 11PK101**

EPA Region 10  
Deemed Releasable

**Date & Time the Incident Began: 11/24/2010 10:20pm**

**Investigation Start Date: 11/29/10**

**Report Date: 1/6/11**

**Incident Summary:**

The HTU#3 Lead Outside Operator working on the HTU/CRU#2 was on his way to close the suction valve on 11PK-101 as part of an emergency unit shutdown following an unresolved 11PK-101 trip. As the operator approached the ladder cage (to the platform the valve was located on), he saw a stream of vapors and oil shooting out of a 2" drain line that was off the 6" vent line from the lube oil reservoir (11T104). He immediately left the area, contacted the console operator to change the plan, and started vomiting. The operator was examined by the PA within an hour and was released back to work.

The incident has been classified as: PSM Near Miss.

A separate Fountain Incident Number ([590910](#)) and investigation has been established for the 11PK-101 trip.

**Situation Description:**

When making his initial round at the start of shift, the #2 Helper noticed the level in 11T104 was a little low and added oil up to its normal level. About two hours later, at 9:06pm, 11PAH2017 alarmed, indicating that the spare lube oil pump had started. The outside operators went out to investigate and while troubleshooting both lube oil and seal oil issues and adding oil to the reservoir, 11PK-101 tripped at 9:51pm.

Because Operations could not determine the cause of the compressor trip, they decided to not restart the compressor and began emergency shutdown procedures. The hydrogen recycle system was still under pressure and the reactors still needed to be swept with H<sub>2</sub>; therefore, it was decided to isolate 11PK-101 from the system and utilize the makeup compressors to conduct the sweep.

The HTU#3 Lead Outside Operator, in assisting the #2 operators in the emergency procedure, went out to the west side of the compressor building and approached the ladder cage leading to the 11PK-101 suction valve, when he noticed that a 2" drain line was shooting a mixture of vapors and oil parallel to the ground about 15' to the North. The operator stopped his approach and immediately left the area. He notified the operators that the area was "gassy" and that the system should be de-pressured as the next step. Soon after, he felt nauseated and started vomiting.

The #2 Lead outside operator immediately escorted him to the Operator shelter and contacted the STL, who called in the PA for examination.

The personal H2S monitor of the #3 lead outside operator did NOT alarm and registered 0ppm H2S. However, the #2 helper's personal monitor has alarmed, detecting 11ppm H2S at 10:15pm. The helper stated he was about 60' southwest of the 2" drain line when his monitor started alarming.

### **Physical Description:**

The lube oil reservoir supplies oil to both the lube oil and seal oil systems, which support the 11PK101 compressor train. Within the compressor, the seals and bearings are located in the same housing. In the event that the pressure drops in the seal oil system and process gas pressure stays high, process gas from the compressor will back into the housing and flow with the lube oil drain back to the lube oil reservoir. The reservoir itself has a continuous nitrogen purge manually controlled by pressure regulator 11PCV-37. The reservoir has a 6" vent leaving the compressor house to the West. The vent has a 2" drain line, which ends about 14" off the ground and has a 90 degree elbow at the end.

### **Sequence of Events:**

~7pm: Helper added lube oil to reservoir  
9:06 pm: Spare lube oil pump auto-started. Operations begin troubleshooting.  
9:51 pm: 11PK-101 tripped  
9:55 pm: Ops begin emergency shutdown procedures  
10:15 pm: Helper's personal H2S monitor alarms  
10:20 pm: #3 operator informs other operators that area is gassy. Ops stop isolation of 11PK-101 and decide to de-pressure system before further attempts at isolation 11PK-101.  
~10:22 pm: #3 operator became nauseated and starts vomiting  
11:20 pm: PA arrives at plant  
11:30 pm: #3 operator released back to work

### **Cause Analysis:**

Refer to the attached cause tree.

***Why was HTU#3 LOO was exposed to H2S vapor on 11/24/10 at 10:20pm?***

1. There was H2S vapor exiting the lube oil reservoir vent line drain.  
AND
2. The drain was installed next to the 11PK101 suction valve platform access.  
AND
3. HTU#3 LOO was approaching the suction valve platform access.

#### ***1. Why was there H2S vapor exiting the lube oil reservoir vent line drain?***

H2S was in the process gas inside 11PK101, which had an open path to the lube oil reservoir. Since the hydrogen recycle system that 11PK101 compresses was still at full pressure, the pressure in 11PK101 was significantly greater than atmospheric pressure. This, in combination with the seal oil barrier pressure being significantly

lower, drove the gases into the bearings (the seals and bearings were in the same housing). Once the gas was in the bearings, it followed the lube oil drain back to the lube oil reservoir.

**2. Why was the drain installed next to the 11PK101 suction valve platform access?**

Both the vent and suction lines were located on the west side of the compressor building. The drain was intended to prevent buildup of liquid level in the vent.

**3. Why was the HTU#3 LOO approaching the suction valve platform access?**

The operator wanted to block in the suction of 11PK101 in order to isolate the shutdown compressor and allow the Makeup compressors to continue H<sub>2</sub> sweep through the reactor system.

**Conclusions:**

<b>Observation</b>	There are paths for process gas to leave 11PK-101 via the seal housing and lube oil reservoir to a 2" vent drain line.
<b>Insight</b>	When the seal oil pressure drops below compressor operating pressure, the equipment is designed to blow process gas out the seal housing and from the 2" drain line outside.
<b>Conclusion</b>	Since the process gas is hydrocarbon and H <sub>2</sub> S, this creates a high risk for people working in the area.

<b>Observation</b>	Operators were working in the immediate physical area of 11PK-101 and were exposed to H <sub>2</sub> S.
<b>Insight</b>	Troubleshooting and isolating 11PK-101 requires the operator to be in the immediate physical area of the vent drain line and inside the compressor house.
<b>Conclusion</b>	When there is a problem with the lube or seal oil system and the process pressure is high, there is additional risk of H <sub>2</sub> S exposure for operators working in an area they need to be in.

**Recommendations:**

<b>1. Process gas out of vent drain line</b>	
<b>What cause should be addressed?</b>	Exposing operators to process gas when blocking in the suction valves to 11PK-101.
<b>Why? What would be the benefit?</b>	Presently the path of the drain is directed towards the ladder cage that operators have to use to block in the suction valves on 11PK-101.  If process gas is leaving the compressor, the vent is where the

	process gas should be flowing so that it can be dispersed to a safe location, rather than the drain line, where it can expose personnel in the area.
<b>How? What would be the solution?</b>	Install spring-loaded valve on the drain line and manage draining any water accumulation via operator rounds.
<b>How would this solution have been corrective, if it had been place?</b>	Gas would not have been going out the drain. It would have been going out the vent that is elevated 30'. The operators would not have to pass through the process gas to reach the suction valves for 11PK-101.
<b>Action Plan:</b>	<p><b>Who:</b> Jim Walker  <b>What:</b> Install 2" spring loaded valve off drain line on 11PK101 lube oil reservoir vent line. Note that it is 2" a threaded line.  <b>When:</b> March 30, 2011</p> <p><b>Who:</b> Darrell Burns  <b>What:</b> Add IntellaTrac round to open 11PK101 lube oil reservoir vent drain once/shift and log whether liquid was noted to accumulate. Must be in conjunction with installation of valve.  <b>When:</b> March 30, 2011</p> <p><b>Who:</b> Darrell Burns  <b>What:</b> Evaluate need for drain line by looking at IntellaTrac drainage history. If not needed (that is, no accumulation noted ever), create WO to remove at next opportunity.  <b>When:</b> July 28, 2011</p>

<b>2. H2S measuring tools</b>	
<b>What cause should be addressed?</b>	Operators unknowingly walking into an environment with H2S.
<b>Why? What would be the benefit?</b>	<p>There are no fixed H2s monitors to warn operators of possible H2S in the area. Limit personnel risk to H2S exposure. Give the operators the ability to put on SCBA's before entering any area that might have H2S in it.</p> <p>In addition, completing recommendation #1 (blocking in the drain) will re-direct any process gases through the vent stack. The vent has a gooseneck at the end (to prevent rain entry) and is located above the roof line near the platform access to the 11PK101 isolation valves. If process gas is in the lube oil vent, it will be directed downwards from the gooseneck and is heavier than air (H2S content). Therefore, there is still some risk of process gases being in the area.</p>

<b>How? What would be the solution?</b>	Fixed Area H2S monitor system where operators are most likely to be exposed (both inside and outside of the compressor house).
<b>How would this solution have been corrective, if it had been place?</b>	The operators would not have entered the area knowing H2S is present.
<b>Action Plan:</b>	<p><b>Who:</b> Darrel Burns  <b>What:</b> Develop a proposal to install a fixed monitoring system for H2S at both the west side of and inside the HTU#2 compressor building.  <b>When:</b> July 28, 2011</p> <p><b>Who:</b> Bobby Otterstetter  <b>What:</b> Consider installing a fixed monitoring system for H2S at both the west side of and inside the HTU#2 compressor building.  <b>When:</b> July 28, 2012</p>

### **Lateral Findings & Recommendations:**

Per PSIA009: "If a [Personal H2S] monitor alarms, the wearer must immediately leave the area, contact the Lead Outside operator or pumper responsible for the area and report the situation. It is also recommended that the wearer visit the medical department."

The current PSI minimizes transfer of knowledge of any H2S exposures to the operating unit team. However, there is a need for management to know and understand the number of occurrences and severity of each H2S exposure and risk at PSR.

Action Plan: HSSE Steering Council to determine personal H2S monitor alarms and reporting philosophy and update standing instruction accordingly.

### **Attachment: Cause Tree**



"Logic tree.pdf"